

What is claimed is:

1. A method of filling one or more of a via and a trench in a patterned substrate, comprising:
 - a) depositing a generally conformal first barrier layer on the patterned substrate by chemical vapor deposition;
 - b) removing the first barrier layer from the horizontal surfaces of the patterned substrate;
 - c) depositing a second barrier layer by physical vapor deposition; and then
 - d) depositing one or more conductive materials.
2. The method of claim 1 wherein depositing the conductive material comprises depositing a seed layer and a metal layer in the via and/or the trench after the second barrier layer is deposited.
3. The method of claim 2 wherein the first barrier layer is selected from the group consisting of Si_xN_y , TiSi_xN , $\text{TiN}(\text{C})$, $\text{TiNSi}(\text{C})$, Ta , TaC , $\text{TaN}(\text{C})$, $\text{TaNSi}(\text{C})$, W , WN_x , SiO_xN_y , SiC , AlN , and Al_2O_3 .
4. The method of claim 3 wherein the second barrier layer is selected from the group consisting of Ta , TaN , TiSiN_x , TaSiN_x , W , and WN_x .
5. The method of claim 4 wherein the seed layer is copper.
6. The method of claim 5 wherein the metal layer is copper.
7. The method of claim 1 wherein the first barrier layer is deposited and removed from the horizontal surfaces of the patterned substrate within a single chamber of an integrated processing tool.
8. The method of claim 7 wherein the chamber is a chemical vapor deposition

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chamber and the first barrier layer is deposited and etched in the chamber.

9. The method of claim 2 wherein the seed layer is deposited by physical vapor deposition.

10. The method of claim 2 wherein the seed layer is deposited by chemical vapor deposition.

11. The method of claim 2 wherein the seed layer is deposited by electroless deposition.

12. The method of claim 2 wherein the metal layer is deposited by physical vapor deposition.

13. The method of claim 2 wherein the metal layer is deposited by chemical vapor deposition.

14. The method of claim 2 wherein the metal layer is deposited by electroplating.

15. The method of claim 1 wherein the via has an aspect ratio of about 4 to 1 and the trench has an aspect ratio of about 1 to 1.

16. The method of claim 1 wherein the second barrier layer has a thickness of from about 20 Å to about 50 Å at the bottom of the via.

17. The method of claim 1 wherein the second barrier layer is selected from the group consisting of Ta, TaN, W, WN_x, Ti, and TiN, and the second barrier layer has a thickness of from about 20 Å to about 50 Å at the bottom of the via.

18. A method of filling one or more of a via and a trench in a patterned substrate, comprising:

- a) depositing a generally conformal first barrier layer on the patterned

substrate by atomic layer deposition;

- b) removing the first barrier layer from the horizontal surfaces of the patterned substrate;
- c) depositing a second barrier layer by physical vapor deposition; and then
- d) depositing one or more conductive materials.

19. The method of claim 18 wherein depositing the conductive material comprises depositing a seed layer and a metal layer in the via and/or the trench after the second barrier layer is deposited.

20. The method of claim 19 wherein the first barrier layer is selected from the group consisting of Ta, TaN, W, and WN.

21. The method of claim 20 wherein the second barrier layer is selected from the group consisting of Ta, TaN, TiSiN_x, TaSiN_x, W, and WN_x.

22. The method of claim 21 wherein the seed layer is copper.

23. The method of claim 22 wherein the metal layer is copper.

24. The method of claim 18 wherein the first barrier layer is deposited and removed from the horizontal surfaces of the patterned substrate within a single chamber of an integrated processing tool.

25. The method of claim 24 wherein the chamber is an atomic layer deposition chamber and the first barrier layer is deposited and etched in the chamber.

26. The method of claim 19 wherein the seed layer is deposited by physical vapor deposition.

27. The method of claim 19 wherein the seed layer is deposited by chemical

vapor deposition.

28. The method of claim 19 wherein the seed layer is deposited by electroless deposition.

29. The method of claim 19 wherein the metal layer is deposited by physical vapor deposition.

30. The method of claim 19 wherein the metal layer is deposited by chemical vapor deposition.

31. The method of claim 19 wherein the metal layer is deposited by electroplating.

32. The method of claim 18 wherein the via has an aspect ratio of about 4 to 1 and the trench has an aspect ratio of from about 1 to about 1.

33. The method of claim 18 wherein the second barrier layer has a thickness of from about 20 Å to about 50 Å at the bottom of the via.

34. The method of claim 18 wherein the second barrier layer is selected from the group consisting of Ta, TaN, W, WN_x, Ti, and TiN, and the second barrier layer has a thickness of from about 20 Å to about 50 Å at the bottom of the via.

35. A method of filling one or more of a via and a trench in a patterned substrate having an etch stop at the via level, comprising:

- a) depositing a generally conformal first barrier layer on the patterned substrate by chemical vapor deposition;
- b) removing the first barrier layer from the horizontal surfaces of the patterned substrate;
- c) removing the etch stop from the bottom of the via;
- d) depositing a second barrier layer by physical vapor deposition; and

then

- e) depositing one or more conductive materials.
36. The method of claim 35 wherein depositing the conductive material comprises depositing a seed layer and a metal layer in the via and/or the trench after the second barrier layer is deposited.
37. A method of filling one or more of a via and a trench in a patterned substrate having a metal layer underlying the via, comprising:
- a) depositing a generally conformal first barrier layer on the patterned substrate by chemical vapor deposition;
 - b) removing the first barrier layer from the horizontal surfaces of the patterned substrate;
 - c) depositing by physical vapor deposition a second barrier layer sufficient to provide a barrier on the bottom of the trench without significantly impairing conduction between the conductive material deposited in the via and the metal layer ; and then
 - d) depositing one or more conductive materials.
38. A method of filling one or more of a via and a trench in a patterned substrate having a metal layer underlying the via, comprising:
- a) depositing a generally conformal first barrier layer on the patterned substrate by atomic layer deposition;
 - b) removing the first barrier layer from the horizontal surfaces of the patterned substrate;
 - c) depositing by physical vapor deposition a second barrier layer sufficient to provide a barrier on the bottom of the trench without significantly impairing conduction between the conductive material deposited in the via and the metal layer ; and then
 - d) depositing one or more conductive materials.

39. An integrated processing tool, comprising:

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a central transfer chamber having a robot assembly disposed at least partially therein for moving substrates;

an chemical vapor deposition chamber for depositing and etching a first barrier layer; and

a physical vapor deposition chamber for depositing a second barrier layer.

40. An integrated processing tool, comprising:

a central transfer chamber having a robot assembly disposed at least partially therein for moving substrates;

an atomic layer deposition chamber for depositing and etching a first barrier layer; and

a physical vapor deposition chamber for depositing a second barrier layer.

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